James City County
Perennial Stream Protocol Guidance Manual

Purpose

This protocol defines the procedure for making field determinations of the presence and the origin of a perennial stream. The procedure was developed to meet the requirement of James City County's Chesapeake Bay Preservation Ordinance, Section 23-8, to perform site-specific field evaluations to determine the boundaries of Resource Protection Areas (RPA) and Section 23-10(2) to identify water bodies with perennial flow. Development of the protocol was finalized using funds from the Chesapeake Bay Implementation Grant #BAY-2007-14-PT awarded to the County by the Department of Conservation and Recreation (DCR).

Introduction

This protocol describes the process of determining whether a stream in James City County has perennial flow, and if necessary, determining the origin of the perennial stream. The origin of the perennial reach may occur as a transition from an ephemeral or intermittent reach or may occur at a spring with no upslope stream channel. The field identification of a perennial stream is based on the combination of hydrological, physical and biological characteristics of a stream. In the protocol, the field indicators of these characteristics are classified as primary or secondary and ranked using a weighted, four-tiered scoring system similar to the current system developed by the North Carolina Division of Water Quality (NCDWQ 2005) as modified to address conditions in James City County. A stream reach is classified as perennial based on the overall score but with consideration of other supporting information such as long term monitoring or historic information in certain situations. The final determination is based on best professional judgment supported by the score on the protocol and other evidence of the character of the stream. Detailed information on the procedure to make the stream classification is presented at the end of this guidance document.

Ephemeral and intermittent streams occur in the uppermost portions of catchments on the York-James Peninsula. Ephemeral streams occur in the highest landscape positions where the channel bed is always above the water table and contain flow only during and shortly after large precipitation events. Intermittent streams usually have channels eroded somewhat deeper into the landscape where the channel bed is **below** the seasonal high water table during the late winter/early spring. Continuous base flow may occur for weeks to months during late winter/early spring and occasionally for short periods during the summer following rainfall events. Perennial streams occur lower on the landscape with channels that are eroded deep enough that the bed is **below** the water table year round during years of normal rainfall. Flow in perennial streams is especially strong and continuous where the channel intersects aquifer layers, including sands or the Yorktown

Formation. The flow in both intermittent and perennial streams is augmented by stormflow during and shortly after rainfall events. Seasonal and long-term variations in climate will cause water table fluctuations that result in variations in the landscape positions of intermittent and perennial stream reaches.

Ditches constructed in wetlands or deep enough in uplands to intersect the water table may exhibit intermittent or perennial flow and develop physical and biological characteristics similar to intermittent or perennial streams.

Definitions

<u>Perennial Stream</u> – A body of water flowing in a natural or man-made channel year-round during a year of normal precipitation. This includes, but is not limited to streams, estuaries, and tidal embayments and may include drainage ditches or channels constructed in wetlands or from former natural drainageways, which convey perennial flow. Generally, the water table is located above the streambed for most of the year and groundwater is the primary source for stream flow. (DCR, 2007) Aquatic biota present are those that require relatively long duration continuous flow.

<u>Intermittent Stream</u> - A body of water flowing in a natural or man-made channel that contains water for only part of the year. During the dry season and periods of drought, these streams will not exhibit flow. Geomorphological characteristics are not well defined and are often inconspicuous. In the absence of external limiting factors such as pollution and thermal modifications, aquatic biota are more limited in numbers of taxa than in perennial streams and are adapted to the wet and dry conditions of the fluctuating water level.

<u>Ephemeral Stream</u> – A channel that carries stormwater only in direct response to precipitation with water flowing only during and shortly after large precipitation events. An ephemeral stream may or may not have a well-defined channel, the aquatic bed is always above the water table, and stormwater runoff is the primary source of water. The stream typically lacks the biological and hydrological characteristics commonly associated with the conveyance of water. (NCDWQ, 2005)

Scoring

Determinations are made on a representative stream reach by examining the metrics over a stream length of at least 200 feet, not at a single point. A reach should have similar physical characteristics and may be bounded by an upstream and downstream tributary, grade control, other physical feature (headcut, pipe, etc.) or an obvious change in channel characteristic (cross-section, sinuosity, slope, etc.). The upper limits of a reach defined as perennial will define the upper limits of a perennial stream. Document the location of the reach with site identification on the data sheet and a field map.

Identification of perennial flow is accomplished by evaluating 14 different attributes (metrics) of a stream and assigning a numeric score to each attribute. A scoring sheet is used to record the score for each metric and then to determine the total numeric score for the stream reach under investigation. A four-tiered, weighted scale is used for evaluating each metric for the reach. The scores of "Absent", "Weak", "Moderate" or "Strong" are applied to the various geomorphic, hydrologic, and biologic metrics. General definitions of Absent, Weak, Moderate, and Strong are provided in the following table. Individual metrics have more specific definitions of the weighting factors contained within each metric description presented later in this document. The final evaluation of the stream classification is presented at the end of this guidance document.

General Guide to scoring categories:

Category	**Description**
Absent	The metric is not observed
Weak	The metric is present but it is necessary to search intensely (requiring several minutes) to find it
Moderate	The metric is present and observable with mild (1 to 2 minutes) searching
Strong	The metric is easily observable

A. Geomorphic Features

1. Bed and Bank

Throughout the length of the stream, is the channel clearly defined by having a consistent and well-defined bank and streambed?

As a general rule, the bed is that part of the channel below the baseflow water line and the banks are that part above the waterline. Usually the bed is kept clear of terrestrial vegetation, whereas the banks are subjected to water flow only during unusual or infrequent high water stages, and therefore, can support vegetation much of the time. The clarity of this indicator lessens upstream as the stream becomes ephemeral. This does not always include a bankfull bench depending on the position in the watershed. Make sure to differentiate between a man-made or modified swale or channel and a natural channel.

S*trong* - There is a continuous bed and bank present throughout the length of the stream channel.

Moderate –The majority of the stream has a continuous bed and bank, however, there are obvious interruptions.

Weak – The majority of the stream has obvious interruptions in the continuity of bed and bank, however, these is still some representation of the bed and bank sequence.

Absent – There is little or no ability to distinguish between the bed and the bank

2. Sinuosity

Is the stream channel sinuous throughout the reach being evaluated?

Sinuosity is a measure of a stream's "crookedness" and is an indication of frequent high energy flows that result in constant dynamic change in a stream channel. It is the total stream length measured along the thalweg divided by the valley length (Figure 1). The larger the number, the higher the sinuosity. Sinuosity is related to slope. Natural undisturbed streams with steep slopes have low sinuosities and streams with low slopes typically have high sinuosities.

Figure 1

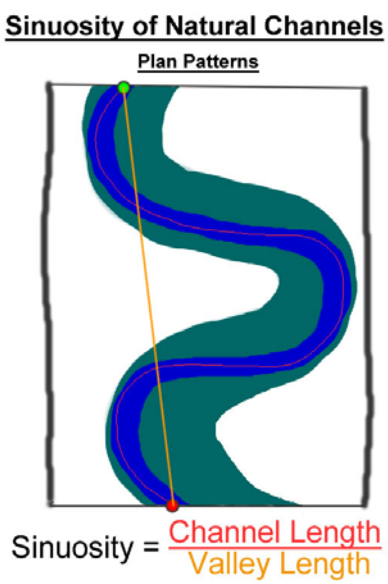
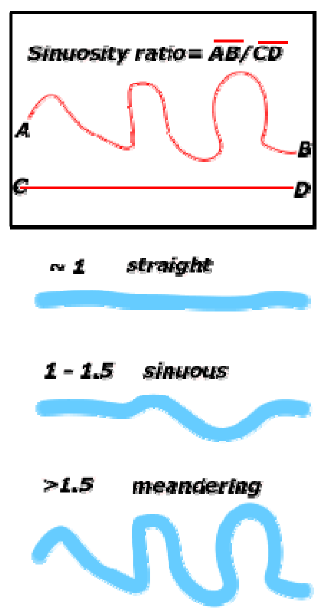


Figure 2



Sinuosity is the result of the stream naturally dissipating its flow forces as the work of channel erosion. Intermittent streams don't have a constant flow regime and as a result generally exhibit a significantly less sinuous channel. While ranking, take into consideration the size of the stream and its watershed, which may also influence the stream wavelength. Sinuosity may be visually estimated or measured in the field. Examples are provided in Figure 2.

Strong – Ratio > 1.4. Stream has numerous, closely spaced bends, very few straight sections.

Moderate – 1.2 < Ratio < 1.4. Stream has good sinuosity with some straight sections.

Weak – 1.0 < Ratio < 1.2. Stream has very few bends and mostly straight sections.

Absent – Ratio = 1.0. Stream is straight with no bends.

3. In-channel Structure – Riffle-Pool Sequences

Is there a regular sequence of riffles and pools or other erosion/deposition structural features in the channel indicative of frequent high flows? Is there evidence of sorting of the bottom substrate materials indicative of frequent high flows?

In-channel structure in a stream channel is the result of frequent high energy flows that transport and redeposit bed substrate materials in the channel. A repeating sequence of riffle/pool (riffle/run in lower-gradient streams or step/pool in higher gradient streams), also called glide/pool, can be observed readily in perennial streams. Riffle-run sequences in low gradient streams such as those found in James City County are often created by in-channel woody structure (such as roots) and debris. When present, these characteristics can be observed even in a dry stream bed by closely examining the local profile of the channel.

A riffle is a relatively shallow flow area along narrower, steeper portions of a stream where the water has a tendency to flow at a higher velocity. In smaller streams, riffles are defined as areas of a distinct change in gradient where flowing water can be observed. Riffles generally contain the heavier soil particles in a stream. A pool is an area of slow moving water where the stream widens and deepens. Pools will typically be located below in-channel obstructions and contain finer soil particles. Along the stream reach, take notice of the frequency between the riffles and pools.

In streams with sandy bed substrate and little or no larger particle distribution, in-channel structure may consist only of ripples or a small scale ripple/pool sequence, or occasionally, pools created by the movement and deposition of woody debris.

The process of development of in-channel structure also results in the sorting of bed substrate particles. Is there an even distribution of various sized substrates throughout the reach or does partitioning or sorting occur? The occurrence of depositional features will be infrequent in intermittent streams. Perennial streams, on the other hand, tend to exhibit correspondingly larger depositional features with larger sized particles being localized in riffles and runs and with accumulations of fine sediments settling out in pools. In James City County, the variability in the size of soil particles is less than in the piedmont and mountains.

Strong – Demonstrated by an even and frequent number of riffles followed by pools/runs along the entire reach. There is an obvious transition between riffles and pools and obvious sorting of the bed materials. Depositional features are present in the channel bed, finer particles are absent or accumulate in pools, and larger particles are located in the riffles/runs.

Moderate – Represented by infrequent number of riffle / pool sequences. Distinguishing the transition between riffles and pools is difficult. Small depositional features are present in the channel bed and sorting of bed materials is limited.

Weak – Streams show either mostly areas of pool or mostly areas of riffles, limited very small depositional features are present in the channel bed and there is little to no sorting of bed materials.

Absent – There is no sequence exhibited or there is no flow in the channel.

4. Soil Texture/Depth of Channel Downcutting Through the Soil Profile

Has channel erosional downcutting penetrated through the soil profile? Is the texture of the bottom substrate different (i.e. much coarser) than that of the soil in the adjacent riparian zone, indicating that finer textured soil particles have been transported out of the reach as the channel eroded downward? Is there sorting of the bottom substrate materials indicative of frequent high flows?

This feature can be examined in two ways. The first is to determine if the soil texture in the stream channel is similar to the soil texture in the surface and subsurface horizons of the soil profile in the adjacent riparian zone. If this is the case, then there may be evidence that erosive forces have not been active enough to downcut the channel and support an intermittent or perennial stream. Soils in the beds of ephemeral channels typically have the same or comparable soil texture as areas close to but not in the channel. However, in urban and suburban areas, storm outfalls often drain runoff directly to the channel and the highly erosive flash flows associated with heavy storm events remove all sized particles and the channel quickly becomes incised. In such situations, ephemeral streams may have relatively large, well developed channels.

The second way the metric can be examined is to look at the granular distribution of the soil in the stream channel. Is there an even distribution of various sized substrates throughout the reach or does partitioning or sorting occur? The occurrence of depositional features will be infrequent in intermittent streams. Perennial streams, on the other hand, tend to exhibit correspondingly larger depositional features with larger-sized particles being localized in riffles and runs with accumulations of fine sediments settling out in pools. In the coastal plain, the variability in the size of soil particles is less than in the piedmont and mountains.

S*trong* – There is a clear distribution of various sized substrates. Depositional features are present, finer particles are absent or have accumulated in pools with larger particles located in the riffles/runs. The bed substrate materials are distinctly different (generally much coarser in texture) than soil particles of the subsurface soil horizon of the adjacent riparian zone. A well-developed channel has downcut through the surface and subsurface horizons of the soil profile and the bed occurs in partially or un-weathered soil parent materials.

Moderate – Various sized substrates are present but represented by a higher ratio of larger particles (rocks and sands). Small depositional features are present; small pools are accumulating some sediment. Some coarse-textured bottom sediments are present that indicate downstream transport. There is a well-developed channel but it is not deeply downcut through the soil profile.

Weak – Substrate sorting is not readily observed. There may be some small depositional features present on the downstream side of obstructions (larger rocks, woody debris, etc.). Some coarse-textured bottom sediments may be present but the channel bed is similar in texture to the subsurface horizon of the soil profile in the adjacent riparian zone. The channel is poorly developed and downcut only partway through the soil profile.

Absent – Substrate sorting is absent. There are few depositional features. There is very little to no channel downcutting and the channel bottom may have soil layering similar to the soil profile in the adjacent riparian zone.

5. Degree of Valley Development

How well-developed is the valley in the vicinity of the stream reach under evaluation? How deep is the valley bottom below the adjacent uplands and how steep are the valley side slopes? How does valley development at the stream reach under evaluation compare to that farther upstream?

An important metric in making determinations of perennial flow in the rolling, dissected Coastal Plain region in which James City County is located is the degree of valley development at the stream reach under evaluation. Streams with relatively deep valleys and steep side walls may have cut deep enough into the groundwater system to maintain year round flows under normal precipitation conditions.

Conversely, a poorly developed valley is generally a strong indicator of intermittent or ephemeral flow. Exceptions may occur in areas where the Yorktown Formation is very close to the surface. In such locations, a small channel in a shallow valley may have incised into the Yorktown Formation sufficiently to exhibit perennial flow. Small, first order spring-fed perennial streams often occur on the slopes of large valleys that are eroded into the Yorktown Formation.

When using this metric, place priority in scoring on the valley depth. Often, the degree of slope and height of the valley are different from one side of the stream to the other. In those situations, rate the metric on an approximate average condition of the two sides. The stream could be located in a wide floodplain, especially if it is near the confluence with a larger stream. The metric needs to be rated based on the slopes at the edge of the floodplain, not in the immediate vicinity of the stream. Also consider the progression of valley development from the stream origin if the reach under evaluation is in headwater (1^{st} or 2^{nd} order) stream segment.

Strong – The valley walls are steep (i.e., generally greater than 25 % slope) and greater than 20 feet in height from the stream bed.

Moderate – The valley walls are moderately steep (i.e., generally 10-25 % slope) with a height of 10-20 feet above the stream bed.

Weak – The valley walls are gradual (i.e. generally 2-10 % slope) with height of less than 10 feet above the stream bed.

Absent – There is no defined valley or a valley is present but nearly imperceptible within a relatively flat landscape position (i.e. less than 2 % slope).

6. Floodplain/In-Channel Bench

Perennial streams usually have well-developed depositional features consisting of alluvium, soil or channel bed particles that have been transported and deposited by stormflow. Such features include floodplains and in-channel benches that may slope up to the bankfull elevation or may occur below bankfull elevation.

Floodplains are relatively flat areas immediately adjacent to streams that dissipate flood energy, provide temporary storage for floodwaters, and accumulate alluvium. The floodplain elevation corresponds to bankfull elevation, i.e. water rising above bankfull spreads over the floodplain. Some indicators include wrack lines, sediment deposition on the ground surface and on plants, flattened vegetation and the presence of distributary (dry) channels that are active only during flooding. Obvious floodplains are better developed in low gradient areas of lesser relief and in higher stream orders; conditions that facilitate lateral migration. In steeper headwater areas, the volume of discharge associated with a bankfull or channel-forming event may be relatively minor. As such, broad, flat classical floodplain features are not manifested. This is often the case in James City County.

In-channel depositional benches may occur in a low order perennial stream with or without the presence of a well-developed floodplain. Point bars or longitudinal benches that are below bank top may be indicative of an incipient (i.e. newly forming) floodplain in an incised stream. In many cases, the observer must look for evidence of an incipient floodplain. Some features may include (Rosgen 1996):

1. point bars – the top of the highest depositional feature is the point of incipient flooding or bankfull stage;
2. a break in the slope of the banks and/or change in particle size distribution;
3. exposed root hairs below an intact soil layer indicating exposure to erosive flow;
4. distinct benches that appear to be frequently inundated.

Geomorphic setting is crucial when evaluating this metric. James City County contains many springs originating from the toe of slopes (example locations, contact with the Yorktown Formation, etc). While these features are perennial, they may not convey any appreciable stormflow (i.e. no bankfull stage) and thus not develop the suite of geomorphic indicators commonly associated with floodplains. Any stream rising from the toe of a significant slope should be carefully examined for evidence of spring discharge (e.g. upwelling, spring boxes, water temperature, contact with the Yorktown formation, $CaCO_3$ deposition, etc.).

Conversely, natural drainage ways subjected to enhanced stormwater discharge or natural streams in rapidly developing catchments may present multiple bankfull indicators due to frequent and voluminous runoff. It is important to evaluate and document all potential upstream water sources, including piped inputs. Bankfull indicators may be present in intermittent streams that route significant stormflow.

In some cases, natural stream courses artificially augmented by stormflow from developed areas may be incised beneath an apparently abandoned floodplain terrace. In this case, look for bankfull indicators within the channel itself as signs of a newly developing floodplain. If none are found, assess the terrace feature for signs of former flooding (e.g. relic distributary channels or swales, variations in sediment texture, old wrack lines, etc.).

When using this metric, first look for the presence of an active floodplain. If none present, then look for a relic floodplain. *If both a floodplain and a bankfull bench are present, evaluate and score based on the more predominate indicator.*

S*trong* – There is a well-developed active floodplain that is continuous on both sides of the stream channel and in-channel benches are present **<u>or</u>** there is a continuous relic floodplain with frequent well-developed in-channel benches, including point bars.

Moderate – An active floodplain is present but is not continuous on both sides of the channel and in-channel benches are present but poorly developed **<u>or</u>**

a discontinuous relic floodplain is present and some in-channel benches are also present.

Weak – An active or relic floodplain is not obvious, however some small depositional features are present in the channel.

Absent – Depositional features are not present.

7. Recent Alluvial Deposits

Are there fresh deposits of alluvial materials that have been transported and deposited on surfaces in the stream channel or on the floodplain by recent high flows?

Alluvium may be deposited as sand, silt, and various sized rock and gravel. Observe whether or not there is any recent deposition or accumulation of these substrates within the stream channel (sand and point bars) or floodplain. Sand-bottom streams by themselves are not necessarily indicative of alluvial deposits. The amount of alluvium deposited will indicate whether water is constantly pushing substrate downstream. Keep in mind that eroding stream channels influenced by stormwater drains and outfalls may score higher than undisturbed channels for this indicator. Also look for the presence of recent construction activity in the stream's watershed.

S*trong* – Large accumulations of sand, silt, or gravel alluvium present in the channel and in the floodplain.

Moderate – Large to moderate accumulations of sand, silt, or gravel mostly present in the channel.

Weak – Small accumulations of sand, silt, or gravel present within the channel

Absent – There are no sand or point bars present within the stream channel and no indication of overbank deposition within the floodplain.

B. Hydrologic Indicators

8. Groundwater Discharge into the Stream

Does the presence of baseflow, and indicators of groundwater presence and groundwater discharge indicate a significant period of groundwater discharge to the stream?

The presence of a seasonal high water table or discharge above the stream bed, seeps or springs, indicates a relatively reliable source of water to a nearby stream. Indicators of a seasonal high water table include visual observation of inundation or soil saturation in the floodplain. Indicators of at least a high water table can be observed by digging a hole in the adjacent floodplain approximately two feet away from the streambed. (This may not be possible in areas with no floodplain such as deep ravines.) The presence of water seeping into the hole (usually a slow process) or the presence of hydric soils indicates the presence of at least a high water table. The presence of iron oxidizing bacteria in the stream bed or on the surface of adjacent wetlands is a good indicator of groundwater discharge. Also look for the presence of spring boxes or other evidence of spring development activities.

The *Munsell Soil Color Charts* book can be used to determine the chroma of the soil matrix/mottles in the hole. Low chroma soils or mottled soils are good indicators of a seasonal high water table. Hydric soils in the sides of a channel or headcut maybe indicators of groundwater discharge. Seasonal high water tables are commonly found in James City County within areas with low relief. Seeps have water dripping or slowly flowing out from the ground or from the side of a hill or incised stream bank. Springs – look for "mushy" or very wet and black decomposing leaf litter nearby in small depressions or natural drainage ways. Springs and seeps often are present at grade controls and headcuts. The presence of this indicator suggests that the stream is being recharged by a groundwater source unless during a period of drought. Score this category based on the abundance of these features observed within the reach.

S*trong* – Spring, seep or groundwater table is readily observable throughout reach.

Moderate – Springs, seeps or groundwater table are present, but not abundant throughout reach.

Weak – Indicators are present but require considerable time to locate.

Absent – No springs or seeps present and no indication of a high groundwater table.

9. Leaf Litter

Are leaves, either freshly fallen or older leaves that may be blackish in color and partially decomposed, accumulating in the streambed?

Perennial streams with deciduous riparian vegetation should transport plant material through the channel frequently during stormflow. In small perennial streams with frequent high energy flows, leaves and other light organic debris will be almost completely scoured downstream except for small accumulations upstream of rocks or large woody debris. Leaves and lighter debris will predominate throughout the length of non-perennial stream channels, whereas there will be little to no leaves present in the stronger flowing area (riffles) with small accumulations on the upstream side of obstructions. This indicator may be hindered during autumn sampling between rain events. This is a secondary hydrologic indicator in which strong evidence receives fewer points than absent (inverse relationship).

S*trong* – Abundant amount of leaf litter is present throughout the length of the stream.

Moderate – Leaf litter is present throughout most of the stream's reach with some accumulation beginning on the upstream side of obstructions and in pools.

Weak – Leaf litter is present and is mostly located in small packs along the upstream side of obstructions and accumulated in pools.

Absent – Leaf litter is not present in the fast moving areas of the reach but there may be some present in the pools.

10. Flowing Water in Channel

It is necessary to discern stormwater inflow resulting from precipitation within the past 48 hours from groundwater inputs. Flow observations should be taken at least 48 hours after the last rainfall. Local weather data and drought information should be reviewed before evaluating flow conditions. Perennial streams will have water in their channels year-round in the absence of drought conditions. If a stream exhibits flowing water in the height of the dry season (mid-summer through early fall in a normal year), then it probably conveys water perennially. On the other hand, a stream that does not exhibit flow during periods of increased rainfall would indicate an intermittent or ephemeral flow. Flow is more readily observed in the riffles and very shallow, higher-velocity area of the stream. Dropping a floating object on the water surface will aid in determining if flow is present.

S*trong* – Flow is highly evident throughout the reach. Moving water is easily seen in riffles and runs.

Moderate – Moving water is easily seen in riffle areas but not as evident throughout the runs, between the riffles and pools.

Weak – Flow is barely discernable in areas of greatest gradient change (i.e. riffles) or a floating object is necessary to observe flow.

Absent – Water present but there is no flow; dry channel with or without standing pools.

11. Yorktown Formation

Is the Yorktown formation exposed in the stream bottom or sides and is water flowing from the formation? Is there evidence of the presence of the formation upstream by the presence of fossilized shells or shell fragments in the stream?

The geologic sequence underlying the York-James Peninsula consists of late Miocene and Pliocene fossiliferous marine sands (Yorktown and Eastover formations), clayey strata and sandy shell beds, fining-upwards late Pliocene, Pleistocene and Holocene units (Bacon's Castle, Windsor, Chuckatuck, Shirley, Tabb, and Kennon formations). The surficial formations, which underlie the succession of terraces, are typically comprised of basal sandy and gravelly beds that grade upward into fine sand, silt and clay-rich surficial deposits. Sandy units exposed along valley walls serve as aquifers that feed perennial streams in the various drainage basins on the Peninsula, such as Powhatan Creek. Soils shown on the soil sheets of the Soil Survey of James City County correlate well with the texture and composition of the formations of each of the terraces. The Yorktown formation consists of alternating layers of limestone, shell beds, or sedimentary sands and clays and can typically be identified by the presence of fossilized shells and a hard clay layer. The shell beds have very high water storage capacity and hydraulic conductivity. The limestone layers frequently have very large dissolution cavities and pipes with very high water storage and transport capacity. Thus the stream channels that have downcut into the Yorktown formation have a very strong and steady groundwater supply.

In other areas of the Coastal Plain of Virginia, there are similar formations such as the Eastover, Chowan and Aquia that underlie the soils in those areas. The composition of these formations is similar to the Yorktown (except the presence of shell material is less prevalent in the Chowan) therefore, if a stream channel has downcut into these formations, there would be a strong and steady groundwater supply generally resulting in perennial flow.

S*trong* – Characteristics are evident and flow is observed from the formation in the side or bottom of the channel. If the formation is not present within the reach, look for the presence of fossilized shells in the stream. Shells are generally intact and make up 50% or more of the stream bottom.

Moderate – Shells are present in the reach and make up between 10 and 50% of the stream bottom. Shells are generally intact but maybe partially decomposed and fragmented.

Weak – Few shells are present accounting for less than 10% of the stream bottom and most are decomposed and fragmented.

Absent – No characteristics or shells are evident in the reach.

C. Biology

12. Macrobenthos

The presence or absence and species diversity of adult and larval stages of aquatic macroinvertebrates, can be good indicators of perennial flow in a stream. Aquatic macroinvertebrates may include but are not limited to caddis fly, mayfly, beetle larvae, damselfly nymph, dragonfly nymph, aquatic worms, and midge larvae. The attached Key may be helpful in identifying different species of aquatic macroinvertebrates (NWCC, 1998). Many invertebrates are unable to maintain populations within intermittent stream channels. Therefore, greater aquatic biological diversity can be an indicator of longer duration of flow. Inversely, decreased aquatic diversity can be an indicator of an intermittent channel. Water striders and surface beetles that can move readily up and downstream should not be considered when evaluating this metric.

Using a 30 mesh D-frame dip net or other aquatic sampling net with a fine mesh (<300 um), sample several habitats within the evaluation reach. Desirable habitats include undercut banks, large woody debris, substrate in riffles, runs, glides and pools, leaf packs, and root wads. Hold the net downstream of the habitat to be sampled, thoroughly agitate the habitat by either jabbing undercut banks or emergent vegetation with the net, kicking the substrate with your feet or using a brush to dislodge invertebrates from smooth flat areas such as trees, bedrock or branches. During and following agitation, sweep the net through the agitated water several times to collect any dislodged macroinvertebrates. Sampling should include a minimum of five (5) habitat jabs within representative habitats be completed to ensure that the biological diversity can be appropriately evaluated.

Pick through the collected debris using either a sieve bucket or sorting pan. Note the number of invertebrates (abundance) and numbers of species present (diversity). Note both the abundance and diversity of your macroinvertebrate sample on the field form when scoring. *High abundance, five or more individuals found in the reach, of two or more species will move the score up one category.*

Use the following guidelines to determine the score.

Strong – Five or more species of macroinvertebrates collected.

Moderate – Three or four species collected.

Weak – One or two species collected.

Absent – No macroinvertebrates were collected

13. Gilled Amphibians

Newts and other gilled amphibians can be found under rocks, on streambanks and on the bottom of the stream channel. They may also appear in the benthic sample. Refer to sampling protocol contained in Item 12, Macrobenthos.

S*trong* – Gilled amphibians are highly evident throughout the reach

Moderate – Gilled amphibians are present throughout most of the reach.

Weak – Gilled amphibians are infrequently found along reach.

Absent – No gilled amphibians present.

14. Fish

Fluctuating water levels of intermittent streams provide unstable and stressful habitat conditions for fish communities. Generally, fish rarely inhabit intermittent streams except when moving upstream into the lower reach of an intermittent stream during periods of relatively high base flow. When looking for fish, all available habitats should be observed, including pools, riffles, root clumps, and other obstructions (to reduce glare, the use of polarized sunglasses is recommended). In small streams, the majority of species usually inhabit pools and runs. Fish should be easily observed within a minute or two. Also, fish will seek cover once alerted to your presence so be sure to look for them slightly ahead of where you are walking along the stream. Check several areas along the stream sampling reach especially underneath undercut banks. This should not be evaluated under conditions of high turbidity in the stream. The mosquitofish (*Gambusia affinis*) often inhabits intermittent streams and ditches and should be discounted as a perennial stream indicator, if present.

S*trong* – Fish are highly evident throughout the reach

Moderate – Fish are present throughout most of the reach.

Weak – Fish are infrequently found along reach.

Absent – No fish present.

Procedure for Flow Classification

The procedure for distinguishing perennial flow from either intermittent or ephemeral flow using this protocol is as follows:

1) Streams scoring 18 points or more will be classified as *perennial*.

2) Streams scoring 10 points or less will be classified as *intermittent*.

3) For streams scoring between 10 and 18 points, the perennial flow threshold is 14 points with a range of +/- 2 points. This means that scores of 14 and above are generally assumed to be perennial and those below 14 will be classified as intermittent. However, the threshold range recognizes that when the score is within 2 points of the threshold value, it is possible that the determination may not be made strictly on the threshold value. Therefore, a stream may be determined to be perennial with a score of 12 or intermittent with a score of 16 if a preponderance of the evidence and professional judgment indicate that it is the appropriate determination.

Variance Procedure – Dispute Resolution

The perennial stream protocol was developed based on extensive application of the protocol throughout the Coastal Plain of Virginia by a team of qualified professionals. General consistency of application of stream metrics and resulting classifications among professionals has been noted here and elsewhere that similar protocols have been used to classify streamflow. Therefore, the described scoring methodology will generally serve as the basis for the flow classification.

However, there may be situations where based on the professional judgment of either the evaluator or the regulator, a flow classification based strictly on the scoring protocol maybe called into question. In these cases, additional field verification information can be gathered and evaluated to make the flow determination. Additional verification can involve the observation or monitoring of flow under certain seasonal or hydrologic conditions. Stream reaches with flow during the dry season (July through September) or periods of drought are likely perennial. Also, information documenting the presence of certain benthic macroinvertebrates that require water for their entire life cycle can be submitted. The NCDWQ method contains lists of benthic macroinvertebrates that require water for their entire life cycle and have been commonly collected from perennial streams in North Carolina. A qualified aquatic biologist/scientist must evaluate the presence and abundance of such species before making the final stream classification based upon benthic macroinvertebrate population considerations.

Another procedure that can be used to settle disputed calls is to use an arbitration process. A mutually agreed upon third party environmental professional(s) can be called upon to evaluate the stream and all information collected to render a professional opinion on the stream classification. Both parties will have to agree to abide by the decision of the arbiter(s).

Modified Streams. Some stream channels have been either modified by man's activities or may be entirely constructed as man-made ditches. In these cases, many of the metrics, especially the geomorphic ones, may be missing or less pronounced than they would be under natural conditions. Therefore, a strict application of the scoring method for determination of perennial flow is not appropriate. Best professional judgment and historic information will be weighted more strongly in these cases. In addition, the DCR guidance document *Determination of Water Bodies with Perennial Flow* (DCR, 2007) needs to be consulted to determine the regulator status of ditches with perennial flow.

Literature Cited

DCR. 2007. Determinations of Water Bodies with Perennial Flow. Guidance on the Chesapeake Bay Preservation Area Designation and Management Regulations. Virginia Department of Conservation and Recreation, Richmond, VA.

NCDWQ. 2005. Identification Methods for the Origins of Intermittent and Perennial Streams. Version 3.1. North Carolina Division of Water Quality, Raleigh, NC.

NWCC. 1998. Stream Visual Assessment Protocol, National Water and Climate Center Technical Note 99-1, USDA Natural Resources Conservation Service, Washington, DC.

James City County Perennial Stream Protocol (5/15/09)					
Date:	Project:				
Evaluator:	Evaluation Point:				
	Indicator Type				
A. Geomorphology (Subtotal =)		Absent	Weak	Moderate	Strong
1. Continuous bed and bank *	Primary	0	1	2	3
2. Sinuosity	Secondary	0	0.5	1	1.5
3. In channel structure: riffle-pool sequence	Primary	0	1	2	3
4. Soil texture/depth of channel downcutting *	Secondary	0	0.5	1	1.5
5. Degree of valley development	Primary	0	1	2	3
6. Floodplain/in-channel bench	Secondary	0	0.5	1	1.5
7. Recent alluvial deposits *	Secondary	0	0.5	1	1.5
B. Hydrology (Subtotal =)					
8. Groundwater discharge	Secondary	0	0.5	1	1.5
9. Leaf litter (inverse relationship)	Secondary	1.5	1	0.5	0
10. Flowing water in channel	Primary	0	1	2	3
11. Yorktown Formation	Primary	0	1	2	3
C. Biology (Subtotal =)					
12. Macrobenthos	Primary	0	1	2	3
13. Gilled amphibians	Secondary	0	0.5	1	1.5
14. Fish	Secondary	0	0.5	1	1.5
* This metric must be evaluated with consideration of upstream conditions, primarily check for presence of					
an upstream stormwater discharge into the reach					
Total Points					
Is the Stream Perennial? **YES NO**					
Reason:					
Additional Factors on which Determination is Based:					
Soil mottling					
Channel geometry, manmade modifications					
Offsite stormflow inputs					
Periphyton					
Grade control					
Primary Indicator is scored from 0 to 3 points, Secondary Indicator is scored from 0 to 1.5 points unless inverse					
relationship. If inverse relationship, Secondary Indicator is scored at 1.5 for absent down to 0 points for strong.					